REMARKS

The invention, as claimed in independent claim 1, relates to an arrangement including a light-emitting power semiconductor device. The device is disposed on a metallic substrate, and a plastic protective body is formed by injection onto the substrate and shrouds the device substantially form-fittingly on its sides and top, leaving a light exit region exposed for coupling to an optical waveguide. Filler particles are dispersed in the plastic protective body. The region between the light-emitting power semiconductor device and the optical waveguide is filled, at least segmentally, with a transparent plastic material. As noted at page 17 of the specification, the metal substrate assists in dissipating heat from the light-emitting power semiconductor device. As also noted at page 17 of the specification (and recited in claim 2), the use of filler particles can favorably affect and improve the thermal adaptation between the power semiconductor device and the plastic protective body.

Claim 1 stands rejected under 35 USC 103(a) as obvious in view of Broom U.S. Patent No. 5,516,727 ("Broom") in view of Tanaka U.S. Patent No. 5,218,611 ("Tanaka"), and further in view of Thillays U.S. Patent No. 4,387,385 ("Thillays").

Broom is cited, with reference to Figs. 4A and 4C, for disclosure of a light-emitting power semiconductor device on a substrate 43 having protective body 45, leaving the light exit region of the device exposed to be coupled to an optical waveguide 42. Thillays is cited for disclosure of a light-emitting power semiconductor device having a metallic substrate and opaque thermoplast with filler particles for thermal conductivity. In the office action it was stated that it would have been obvious to modify Broom to have a metallic substrate to provide adequate conductive connection, referencing col. 1, lines 8-14 of Thillays, to provide filler particles for thermal conductivity, referencing col. 1, lines 13-18 of Thillays, and to fill the space between the device and the waveguide with a transparent plastic material citing col. 2, lines 44-56, apparently of Tanaka.

As has been noted previously, the fundamental teaching of of Broom is that an "air" gap or a region filled with an inert gas be provided in direct contact with the light emitting facet of the chip region. At col. 2, lines 4 to 14, Broom recites that it is an object of the invention to

provide a hermetic encapsulation. Broom further recites that this object is accomplished by providing an air gap in direct contact with the light emitting facet of a light emitting diode while leaving the remaining portions of the diode sealed in the encapsulate. Broom thus does not induce a skilled person to fill the region between the semiconductor device and the optical wave guide with a transparent plastic material but instead quite clearly and emphatically teaches the opposite, that there should be an air gap. The office action states that "although Broom discloses the existence and the benefit of an air gap between the optical waveguide and semiconductor laser provided by an encapsulant, the Broom reference clearly teaches that other embodiments exist without an encapsulant." This statement appears to be in error, as all embodiments of Figs. 1-5 are described as having encapsulation. It is believed that the statement may instead have intended to refer to the lack of an air gap in the criticized "Prior Art" embodiment of Fig. 1, which has an encapsulating resin 14 between the device 10 and cube 12 with a 45° mirror facet 13. This Fig. 1 prior art embodiment and its direct contact are criticized in the following passage:

> A disadvantage of hermetically sealing light emitting diodes using an encapsulant is illustrated in FIG. 1. In it, the encapsulant adheres to the light emitting facet. Thus, it directly interacts with it and causes thermal problems if light beams with high optical flux density are to be generated. Furthermore, chemical changes in the encapsulant caused by high optical flux, can accelerate degradation (corrosion) of the facet. (Col. 1, lines 60-67).

The examiner does not rely on the Fig. 1 embodiment in the office action, but instead relies on the Figs. 4A and 4B embodiment which quite clearly has an air gap as described at col. 3, line 63-col. 4, line 38. One skilled in the art would not modify Fig. 4 to omit the air gap that is the sine qua non of this embodiment and the Broom patent.

Tanaka is even less relevant than Fig. 1 of Broom, in that Tanaka does not disclose a space between the solid state waveguide (17) and the semiconductor device but instead has the waveguide, realized by a solid substance such as a resin, directly in contact with one light emitting face ("rear cleavage face 4Ab") of the laser diode chip so that the signal between the laser diode chip and the monitor element is not altered by contaminants such as dew or dust (col. 2, lines 8-13). This does not provide any motivation whatsoever with respect to the Figs. 4A, 4B

embodiment of Broom, which already has hermetic encapsulation, and which has an air gap as a critical feature of the teaching.

The reliance on Thillays in combination with Broom to provide the metal substrate and filler features is also in error. In the "Response to Arguments" section of the Office Action, it is stated that Thillays provides that it would have been obvious to a skilled person at the time the invention was made to have used a plastic protective body made from thermoplast characterized with glass filler particles for thermal "conductivity" (apparently intended to refer to thermal compatibility), to provide reflectivity and to ensure mechanical coherence and protection.

Thillays, however, discloses a display device where a block (Figure 3, 13) and a base (Figure 3, 10) are manufactured from the same material. The block and base thus have the same coefficients of shrinkage upon molding and the same coefficients of expansion upon heating (see col. 2, lines 16 to 21). For that reason there is no need for filler particles which adjust the thermomechanical properties of block and base from Thillays' point of view. As a result Thillays does not induce a skilled person to use filler particles for any thermocompatibility reasons.

The reflectivity used in Thillays involves using filler particles to provide reflectivity of e.g. the surface of the block, as noted at col. 2, lines 22 to 26 and col. 4, lines 8 to 10 of the reference. There Thillays discloses that base and block are made from a thermoplastic material filled with a white-tinted pigment (e.g. 10 to 30% titaniumoxide powder). This results in a opaque block and base with reflective properties which are at least equal to those of a silver-plated or gold-plated surface (col. 2, lines 22 to 27), which is what was used in the prior art devices having apertures that contained air and were defined by metal coated surfaces as light conductors (col. 1, lines 18-33). The only way one can base a motivation to use the reflectivity teaching in Thillays to combine with Broom is if one retains Broom's essential teaching of an air gap and perhaps somehow wants to provide a reflectivity around the light conductors of the air gap. While this arguendo only might provide a reason to use a filler in Broom, it would not result in the invention as claimed, as it would involve air gap light conductors provided by apertures.

The office action further states that a skilled person would be motivated to fill the interstitial space between the blocks to ensure mechanical coherence and protection of the arrangement noting col. 1, lines 13-18 of Thillays. That passage refers to a first group of display device which is different than the second group of display devices to which the Thillays invention belonged. The second group involves open air light conductors with reflective walls. E.g., Thillays discloses a flat filtration panel (Figure 3, 16) which is placed on the block (Figure 3, 13). Surely this panel provides protection and ensures mechanical coherence of the display device and is also suited to minimize due and dust formation in the device. It also would not make sense to fill the interstitial space with an opaque material. In this case the opaque material would cover the light emitting diode (Figure 3, 12) and no light could escape from the display device.

Thillays also does not teach the use of a metal plate in the claimed combination. The reference to a metal plate in the prior art at col. 1, line 26 is contrary to the air light conductor teachings of Thillays relied upon for filler. It is the point of Thillays' invention that block and base (substrate) are made of the same thermoplastic material. For that reason Thillays' device is distinguished by low production costs and a small number of operations necessary for assembly (see e.g. column 4, lines 55 to 60). As a further advantage of such an arrangement, the body and base have the same thermodynamic properties. A metallic substrate thus would counteract all the benefits of Thillays' invention.

The cited references, taken alone or in combination, do not suggest the subject matter of independent claim 1, and it is allowable under 35 USC 103(a). Claims 2-15 and 20-25 depend on claim 1 and are allowable with it.

Independent claim 16 is directed to a method of making an arrangement involving placing a semiconductor device on a substrate, affixing an optical waveguide to the substrate, injection coating the optical waveguide to completely shroud it in plastic forming a protective body, and exposing a light exit surface of the optical waveguide in the outer periphery of the plastic protective body. In particular, claim 16, requires the following third and fourth steps not disclosed in Broom.

in a third step, said substrate structure with said light-emitting power semiconductor device is injection-coated with a plastic mass forming a plastic protective body, characterized in that in the third step, said optical waveguide is completely shrouded in said plastic protective body, and

in a fourth step, a light exit surface of said optical waveguide is exposed in the region of the outer periphery of said plastic protective body.

The Office Action relies on Fig. 4c for the third step. With respect to Fig. 4c, it is merely said "encapsulant 45 is flowed over laser 40 and fiber 42" (col. 4, lines 29-30). What happens at the end of fiber 42 is not shown in Fig. 4c or described in the text. Presumably the encapsulant ends at the end of base 43 and the fiber continues without encapsulant on it. In any event, there is no disclosure of completely shrouding the optical fiber in encapsulant (the third step) and then exposing a light exit surface in the fourth step.

The cited references, taken alone or in combination, do not suggest the subject matter of independent claim 16, and it is allowable under 35 USC 103(a). Claims 17-29 depend on claim 16 and are allowable with it.

Please apply any charges or credits to deposit account 06-1050, referencing Attorney Docket No. 12406-011001.

Respectfully submitted,

Date: July 19, 2004

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